REMARKS

The Final Office Action dated January 13, 2009 has been carefully considered. Claims 13-27 were pending, of which claims 19, 21 and 24 were withdrawn previously in response to restriction and election of species requirements. Claims 13-18, 20, 22, 23, and 25-27 were rejected and at issue. Claim 13 has been amended to more clearly state the claimed features that are distinguishable from Goedicke et al. and Hörzenberge. No new matter has been added by this amendment. Reconsideration and indication of the allowability of claims 13-18, 20, 22, 23, and 25-27 in view of the foregoing amendments and following remarks are respectfully solicited.

The Applicants would first like to thank Examiner Walters and Supervisor Barr for taking time to discuss the present application with the undersigned attorney during the interview dated February 9, 2009. During this interview the undersigned attorney reiterated that Hörzenberge discloses the use of infra red (IR) radiation to cure a paint layer and does not teach or suggest IR radiation treatment of a metallic coating on a metal substrate. Further, Goedicke et al. nor Hörzenberge provides any reason that would have led one of ordinary skill in the art to believe that the use of the IR radiation to diffuse an additional metallic element into a metallic coating would be successful. In fact, one of ordinary skill in the art confronted with Hörzenberge's teaching that IR radiation is absorbed by the paint layer, which has a high heat absorption characteristic, and not by the metal surface, which exhibits a high reflectivity, would haven been prompted **not** to use IR radiation for metal coated surface. However, the Examiner, the Supervisor and the undersigned attorney were not able to reach an agreement during this interview. After the Interview, the Applicant filed a Notice of Appeal dated July 9, 2009. However, the Applicants became aware of new references, for example, via foreign patent offices prosecuting corresponding foreign applications. Thus, the Applicants hereby file a Request for Continued Examination and this Amendment along with a Supplemental Information Disclosure Statement including the new references. Although the Applicants believe that the pending claims were patentable over the cited references, the Applicants have amended independent claim 13 to more clearly state the claimed features that are distinguishable from Goedicke et al. and Hörzenberge to facilitate the prosecution of the present application. Therefore, the Applicants respectfully request the

Examiner to reconsider all pending claims in view of the foregoing amendment and the following remarks.

The Examiner has rejected claims 13-15, 17, 18, 20, 22, 23, 25, 26, and 27 under 35 U.S.C. §103(a) as being unpatentable over Goedicke et al., DE 19527515, in view of Hörzenberger, EP 1201321. Reconsideration of this ground of rejection and indication of allowability of claims 13-15, 17, 18, 20, 22, 23, 25, 26, and 27 in view of the foregoing amendment and the following remarks are respectfully solicited.

To establish *a prima facie* case of obviousness, there must be "a reason that would have prompted a person of ordinary skill in the relevant field to combine elements in the way the claimed new invention does." *KSR Int'l Co. v. Teleflex Inc.*, 127 S.Ct. 1727, 1741. It is impermissible to use the claimed invention as an instruction manual or "template" to piece together isolated disclosures and teachings of the prior art so that the claimed invention may be rendered obvious. *Ex parte Haymond*, 41 U.S.P.Q. 2d 1217, 1220 (B.P.A.I. 1996). The Examiner has the initial duty of supplying the factual basis for the rejection that he/she advances and the Examiner may not, because he/she doubts that the invention is patentable, resort to speculation, unfounded assumptions or hindsight reconstruction to supply deficiencies in the factual basis. *Id., citing In re Warner*, 379 F.2d 1011, 1017 (CCPA 1967), cert. denied, 389 U.S. 1057 (1968).

In this case, the Applicants respectfully submit that there is no reason that would have prompted a person of ordinary skill in the art to combine elements of Goedicke et al. and Hörzenberge in the way the Examiner suggested, as discussed in detail below. Therefore, the Examiner has resorted to speculation, unfounded assumptions and hindsight reconstruction of the claims to support the obviousness rejection over the prior art.

As amended, independent claim 13 now recites, *inter alia*, "diffusing an additional metallic element to said metallic coating to form an intermetallic compound . . . wherein said additional metallic element is added through a physical vapour deposition technique; and wherein thermal treatment is applied by directing high energy infra red radiation towards the

outer surface of said metallic coating, the thermal treatment heating the steel product from outside to diffuse the additional metallic element into the metallic coating without affecting an interface between the steel substrate and the metallic coating."

In rejecting claims 13-15, 17-18, 20, 22, 23, 25, 26, and 27 the Examiner relied on Goedicke et al. for a metallic coating (Zn coating) on a steal product and addition of an additional metallic element through a physical vapor deposition technique. Further, the Examiner admitted that Goedicke et al. "fails to teach the thermal treatment (recited in claim 13) being applied by directing high energy infra red radiation towards the outer surface of said coating." To cure this deficiency, the Examiner cited the Hörzenberger reference.

However, Hörzenberger fails to teach or suggest the use of the IR radiation to diffuse an additional metallic element added via physical vapour deposition into the metallic coating, as claimed in the amended claim 13. Instead, Hörzenberger teaches a method of producing a pre-painted metal substrate. The IR radiation treatment in the Hörzenberger reference is used for curing an organic paint coated on the surface of a pre-treated metal substrate. Hörzenberger teaches that the IR radiation is effective for curing such a paint layer because organic paints have high IR radiation heat absorption properties. Specifically, Hörzenberger, in paragraph [0026] states "[t]he high energy near infra red radiation is absorbed by the whole paint layer and transferred by heat conduction into the sheet." Then, in paragraph [0032], Hörzenberger explains that the paint layer has a "higher [IR] heat absorption", while the metal surface "exhibits a high reflectivity."

As quoted, Hörzenberger teaches that the IR radiation is efficient for curing an organic paint due to the high IR radiation heat adsorption properties of the organic paint. Further, Hörzenberger implies that the IR radiation would be ineffective on a metallic surface by stating that the metal surface has a high reflectivity. Thus, there is no reason that would have prompted one of ordinary skilled in art confronted with such teachings of Hörzenberger to modify the Goedicke et al. reference as suggested by the Examiner to use the IR radiation treatment on a metal coated substrate without any organic coating. Therefore, the Examiner

has resorted to speculation, unfounded assumptions and hindsight reconstruction of the claims to support the obviousness rejection over the prior art.

The Examiner argues that since Hörzenberger teaches applying the IR radiation to both the coated side and the uncoated side of the metal sheet when the metal sheet is coated with a thick layer of organic coating, this suggests that not all of the IR radiation is reflected and can be used to thermally anneal the organic coating on the other side. Final Office Action dated January 13, 2009, at page 2. However, and as stated by the Examiner, Hörzenberger uses the IR radiation to "anneal" or heat the organic coating. Again, nowhere does Hörzenberger teach using the IR radiation for diffusing an additional metallic element into a metallic coating or suggest that such application of the IR radiation would be successful. Thus, the Applicants respectfully submit that the fact that Hörzenberger teaches that the metal substrate coated on one side with an organic coating can be irradiated from both sides would not lead the one of ordinary skill in the art towards any useful information about the IR radiation treatment of a metallic coating to diffuse an additional metallic element added by physical vapour deposition. Neither Horzenberger or Goedicke et al. provide any reason that would have prompted one of ordinary skill in the art to believe that the IR radiation treatment would be effective in obtaining the required diffusion of the additional metallic element into the metallic coating to obtain an intermetallic compound between the metal coating (e.g. Al-Zn) and the added metallic element (e.g. Mg) as claimed in claim 13 and its dependent claims 14 and 15. Reconsideration of independent claim 13 and its dependent claims 14-15, 17, 18, 20, 22, 23, 25, 26, and 27 in view of the foregoing amendment and remarks are respectfully solicited.

Additionally, to more clearly demonstrate that the IR radiation treatment to diffuse an additional metallic element into a metallic coating to form an intermetallic compound is not obvious over Hörzenberger, which only teaches the IR radiation treatment of an organic coating on a metal substrate, the Applicants brings the Examiner's attention to FR2655058 to Bretez, which is attached in Exhibit A along with its English translation. (Bretez was included in the International Search Report and cited in the Information Disclosure Statement dated April 27, 2006)

Bretez describes a process that includes adding an additional element to a metallic coating and heat treating by IR radiation. According to Bretez, the additional element can be Al or Fe, which is applied in a powder form, on top of a galvanized steel sheet and heated by the IR radiation. Bretez describes the effect of the IR radiation treatment as a thermal 'shock', which avoids the diffusion of Al into the Zn-layer. *See* English translation of Bretez at page 4, lines 22-31. As the interaction between Zn and the added Al is not desired in Bretez, no diffusion of Al in Zn is satisfactory. *See Id.* at page 5, lines 12-14.

When the additional element is an Fe-powder, a small degree of diffusion of the Fe into the Zn is observed. *See Id* at page 2, lines 24-28. However, both in the case of Al and of Fe, Bretez is aimed at maintaining a two-layer structure: a Zn-layer covered by an Al layer or a Zn-Fe layer. *See e.g.* FIG. 3 and page 5, lines 6-20, stating a significant diffusion would be detrimental to "forming a heterogeneity of the latter coating."

In method of claim 13 and its dependent claims, however, the diffusion of the added element, e.g. Mg, into the metallic coating is required to form an intermetallic compound, which replaces the original metal coating, while at the same time minimizing diffusion of Fe (of the substrate itself) into the metal coating.

As discussed above, in Bretez, the IR heating allows no or a minimal diffusion of the added element into the metal coating, and is therefore clearly counterintuitive to the use of the IR radiation treatment to diffuse the additional metallic element into the metal coating to form an intermetallic compound as claimed in claim 13. The Applicants believe that the different behavior of the added element in terms of diffusion into the metal coating is linked to the use of a powder for adding the additional element in Bretez, whereas the method of claim 13 uses a physical vapor deposition technique. In any case, such different result in metallic coatings treated with the IR radiation clearly demonstrates that selection of type of heat treatment is not so random and obvious as the Examiner suggested. As discussed above, Goedicke et al. nor Hörzenberge provides any reason that would have led one of ordinary skill in the art to use the combination of the IR radiation treatment and the physical vapor

deposition technique to diffuse an additional metallic element into the metallic coating to form an intermetallic compound. Reconsideration of claims 13-15, 17, 18, 20, 22, 23, 25, 26, and 27 in view of the foregoing amendment and remarks are respectfully solicited.

Conclusion

The application is considered in good and proper form for allowance, and the Examiner is respectfully requested to pass this application to issue. If, in the opinion of the Examiner, a telephone conference would expedite the prosecution of the subject application, the Examiner is invited to call the undersigned attorney.

Extension of Time and Fee Deficiency

The Applicants believes that a five-month extension of time from filing of the Notice of Appeal is required. However, this conditional petition is being made to provide for the possibility that the Applicants have inadvertently overlooked the need for a petition and fee for extension of time. If any additional fee is required, or any overpayment is made, in connection with this communication please charge or credit deposit account No. 50-3505.

Respectfully submitted,

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EXHIBIT A

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(12) **DEMANDE DE BREVET D'INVENTION** **A1**

(22) **Date de dépôt** : 30.11.89.

(30) **Priorité :**

(43) **Date de la mise à disposition du public de la demande :** 31.05.91 Bulletin 91/22.

(56) **Liste des documents cités dans le rapport de recherche :** *Se reporter à la fin du présent fascicule.*

(60) **Références à d'autres documents nationaux apparentés :**

(71) **Demandeur(s) :** *FABRIQUE DE FER DE MAUBEUGE (Société anonyme)* — FR.

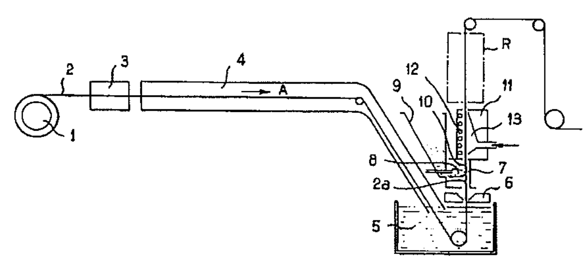
(72) **Inventeur(s) :** Bretez Michel.

(73) **Titulaire(s) :**

(74) **Mandataire :** Cabinet Boettcher.

(54) **Procédé de revêtement d'une plaque ou tôle métallique dont au moins une face possède un double revêtement minéral - Plaque bande issue du procédé.**

(57) Par ce procédé, on ensemence au moins une face de la bande (2) sortie du bain de galvanisation avec une poudre métallique ou organique, le zinc étant encore liquide et on procède à un chauffage superficiel de cette face (2a) au moyen d'émetteurs d'infrarouges (12) simultanément à un refroidissement énergique par fluide réfrigéré (13) de l'autre face.



FR 2 655 058 - A1

L'une des techniques les plus répandues pour assurer la protection d'une tôle métallique en acier est la galvanisation au trempé en continu. La couche de protection ainsi réalisée est le plus souvent un alliage à base de zinc. Le défaut essentiel du zinc est une résistance moyenne à la corrosion. Pour le pallier, on a imaginé diverses techniques portant notamment sur l'addition d'une certaine quantité d'aluminium dans le bain de revêtement (typiquement 5 %) voire de créer un alliage Aluminium Zinc (contenant typiquement 55% d'Aluminium). Ces alliages présentent cependant, par rapport aux alliages classiques à plus de 95 % de Zinc l'inconvénient de n'offrir qu'une faible protection galvanique des rives. Ils sont ensuite de mise en oeuvre plus coûteuse, nécessitant des températures de bain plus élevées. D'autres techniques consistent à réaliser un prélaquage en ligne derrière la galvanisation, la couche de peinture déposée sur la couche de zinc augmentant la résistance du revêtement. Les produits résultant de cette technique ne sont pas d'emploi universel compte tenu de la relative fragilité du revêtement organique qui résiste mal aux opérations de formage ultérieures.

Il est également connu, pour rendre le produit plus facilement soudable, de procéder après la galvanisation au trempé, à un traitement thermique du produit galvanisé pour favoriser la formation d'un alliage intermétallique fer-zinc qui possède les qualités requises pour une bonne soudabilité. En revanche cet alliage est cassant et la tôle se prète mal à des opérations avec déformation importante, au cours desquelles on assiste à une perte d'adhérence du revêtement.

La présente invention entend proposer un autre type de revêtement, comportant toujours du zinc qui est un matériau facile à mettre en oeuvre et relativement bon marché, qui puisse répondre de manière optimale aux diverses contraintes auxquelles une tôle "galvanisée" est soumise tant du point de vue de la corrosion que du domaine d'emploi.

A cet effet, elle a pour premier objet un procédé

de production d'un matériau métallique revêtu, consistant à réaliser le revêtement d'un substrat de base en forme de plaque ou bande par trempage de ce substrat dans un bain de zinc ou d'alliage de zinc et à projeter sur la pellicule de zinc encore en fusion, portée par au moins une face du substrat, un autre composé minéral sous forme de poudre, qui comprend au moins l'étape supplémentaire d'échauffer la face ensemencée par le moyen d'une source de chaleur radiante et de refroidir simultanément et de manière énergique la face opposée du substrat.

Il résulte de ce procédé une fusion de l'élément pulvérulent qui constitue une couche continue à la surface du zinc dont la nature dépend de l'élément minéral et qui préserve une sous-couche de zinc (ou d'alliage) assurant la protection galvanique des rives d'une pièce de tôle ainsi revêtue.

C'est notamment le cas lorsque la poudre est une poudre d'aluminium. Dans ce cas, outre la protection galvanique des bords, la résistance à la corrosion du produit est très importante car le "film" d'aluminium surmontant le zinc s'oxyde en surface, une couche d'alumine étanche protégeant ainsi toutes les sous-couches.

Quand la poudre est du fer, il se forme une légère diffusion du fer dans la couche supérieure du zinc pour former un alliage intermétallique delta fer-zinc qui est très soudable. Bien que cet alliage soit dur, la sous-couche de zinc constitue une sorte de liant qui conserve l'adhérence du revêtement au substrat de base.

La poudre minérale peut être constituée par un autre produit tel qu'une céramique ou un oxyde métallique qui se "vitrifie" sous l'effet du rayonnement calorifique.

Le procédé selon l'invention peut comporter une étape intermédiaire consistant à compacter la poudre projetée sur le film de zinc avant le traitement thermique. Ce compactage peut être réalisé par laminage sous faible pression.

Le procédé de l'invention s'applique comme une étape

ultérieure d'une galvanisation au trempé continue ou discontinue. Dans le cas d'une galvanisation continue, le substrat étant une bande continue, le procédé consiste à faire défiler la bande successivement dans un bain de zinc ou d'alliage de zinc fondu, dans une enceinte de projection de la poudre minérale puis dans une enceinte thermique comportant d'un côté de la bande des éléments radiants de chauffage et de l'autre côté un dispositif de réfrigération de la bande par conduction.

Le cas échéant, avant l'entrée de la bande dans l'enceinte thermique, la bande passe dans un poste de compactage et d'étalement de la poudre, ce poste comportant à cet effet un laminoir basse pression.

Le second objet de l'invention réside en un produit qui comporte, sur un substrat en forme de plaque ou bande d'acier, une face recouverte d'une couche de zinc et une autre face recouverte d'un revêtement composé d'une sous couche de zinc recouverte d'une couche minérale continue, cette couche minérale pouvant être constituée par une couche métallique typiquement de l'aluminium, un alliage fer zinc ou une céramique vitreuse ou non.

L'exemple de réalisation de l'invention donné ci-après concerne un procédé de fabrication d'une tôle galvanisée sur ses deux faces et recouverte sur l'une d'elles d'une couche mince d'aluminium.

Il sera fait référence aux dessins annexés dans lesquels :

- la figure 1 représente schématiquement une ligne de production en continu d'un tel produit,
- la figure 2 illustre une variante de réalisation de la figure 1 possédant un poste de compactage de la bande métallique ensemencée,
- la figure 3 est une coupe d'une bande métallique, revêtue, conformément à l'invention.

Une bobine de feuillard d'acier 1 délivre une bande 2 qui, après passage dans des unités de préparation thermiques

et/ou chimiques 3 et 4 défile dans un bain 5 de zinc ou d'alliage de zinc fondu, dans le sens A. Un dispositif 6 d'essorage permet de régler l'épaisseur de la couche de zinc, entraînée par la bande, qui demeure liquide. La bande entre dans une enceinte 7, au besoin maintenue en température dans laquelle elle reçoit, sur l'une de ses faces 2a une projection (pneumatique ou autre) de poudre d'aluminium, au moyen d'un système de projecteur 8 alimenté par une trémie 9. La poudre d'aluminium 10 est retenue et entraînée par la bande, ou du moins une certaine fraction de celle projetée qui elle aura été réglée en fonction de la vitesse de défilement de la bande et de nombreux autres paramètres de façon à obtenir l'épaisseur finale d'aluminium dont on veut voir recouvert le produit.

La bande pénètre ensuite dans une enceinte thermique 11 qui possède du côté de la face 2a, ensemencée de poudre d'aluminium, une batterie 12 d'éléments de chauffage radiant et de l'autre côté un dispositif de refroidissement énergique 13, par exemple une buse de soufflage d'un gaz refroidi 13a par détente ou vaporisation à partir de son état liquide (du CO_2 notamment).

Les éléments 12 peuvent être de tout type connu. Ils comprennent ainsi les sources infrarouge et les sources de rayonnement laser.

Dans cette enceinte thermique la batterie d'éléments radiants est disposée de manière telle que la bande est soumise à un "choc" thermique important. On constate que le rayonnement n'a qu'un effet très superficiel sur la face 2a et que la chaleur est concentrée à la surface du zinc sur laquelle les grains d'aluminium transformés en un film liquide forment une barrière supplémentaire réfléchissant le rayonnement infrarouge. Ce type de chauffage, qui profite au maximum de l'inertie thermique de la sous-couche métallique, allié au refroidissement énergique de l'autre face, interdit pratiquement toute diffusion de l'aluminium dans la couche de zinc.

La figure 2 diffère de la figure 1 par la mise en place

d'une section 14 de compactage de la poudre dans la matrice de zinc et d'amélioration de sa répartition. Cette section est interposée entre l'enceinte 7 de projection et l'enceinte 11 de traitement thermique. Elle peut être simplement constituée par un laminoir agissant avec une pression faible sur la bande 2.

Le produit obtenu après refroidissement, au besoin à l'aide d'une section de refroidissement R, vu en coupe grossie, se présente comme représenté à la figure 3.

L'âme 15 en acier du produit est recouverte sur ses deux faces d'une couche de zinc 16, avec une zone d'interface 17 dans laquelle on trouve des alliages intermétalliques fer-zinc. Sur la face ensemencée de poudre d'aluminium, correspondant à la face 2a de la figure 1, on trouve un film d'aluminium 18, dont l'épaisseur dépend de la quantité de poudre "piégée" par le zinc liquide dans l'enceinte 7 de projection, qui présente une frontière inférieure 19 très nette avec le zinc en sous-couche. On constate qu'il n'y a pratiquement eu aucune diffusion de l'aluminium dans le zinc, ce qui est très appréciable dans le cas d'un tel revêtement. En effet, s'il avait eu une diffusion importante, celle-ci aurait certainement engendré la formation de Fe_2Al_5 qui est un composé très dur pouvant nuire à la bonne tenue du revêtement aux déformations qu'il est destiné à subir lors du formage des tôles, et en tout état de cause, constituant une source d'hétérogénéité de ce dernier.

L'exemple décrit n'est pas limitatif et l'invention concerne tout produit recouvert de cette manière avec un composé minéral projeté sur une couche de zinc encore en fusion et chauffé très rapidement par rayonnement infrarouge ou laser pour en obtenir la fusion et son étalement en forme de couche superficielle sur le zinc. Ainsi la poudre peut être du fer et dans ce cas, on assiste à une diffusion du fer dans le zinc sur une faible épaisseur pour produire un alliage intermétallique de type delta qui améliore la soudabilité du produit.

Etant donné la concentration importante des calories radiées à la "peau" du zinc, on peut atteindre des températures élevées permettant une " vitrification" d'oxydes minéraux ou de céramiques.

REVENDICATIONS

1. Procédé de production d'un matériau métallique revêtu, consistant à réaliser le revêtement d'un substrat (2,15) de base en forme de plaque par trempage de ce substrat dans un bain (5) de zinc ou d'alliage de zinc et à projeter sur la pellicule de zinc encore en fusion, portée par au moins une face (2a) du substrat, un autre composé minéral sous forme de poudre, caractérisé en ce qu'il comprend au moins l'étape supplémentaire d'échauffer la face (2a) ensemencée par le moyen d'une source de chaleur radiante (12) et de refroidir (13) simultanément et de manière énergique la face opposée du substrat.

2. Procédé selon la revendication 1 caractérisé en ce qu'il comporte l'étape préalable à l'échauffement, de compactage de la poudre dans la matrice de zinc.

3. Procédé selon la revendication 1 ou la revendication 2 caractérisé en ce que la poudre minérale est une poudre d'aluminium.

4. Procédé selon la revendication 1 ou la revendication 2 caractérisé en ce que la poudre minérale est une poudre de fer.

5. Procédé selon l'une quelconque des revendications précédentes caractérisé en ce que le substrat, étant une bande continue (2) il consiste à faire défiler la bande (2) successivement dans un bain (5) de zinc ou d'alliage de zinc fondu, dans une enceinte (7) de projection de la poudre minérale puis dans une enceinte (11) thermique comportant d'un côté de la bande des éléments radiants (12) de chauffage et de l'autre côté un dispositif (13) de réfrigération de la bande par conduction.

6. Procédé selon la revendication 5 prise en dépendance de la revendication 2 caractérisé en ce qu'il consiste à faire passer la bande dans un laminoir (14) après l'enceinte de projection (7) et avant l'enceinte thermique (11).

7. Produit en plaque ou en bande revêtu caractérisé en ce qu'il comporte, sur un substrat en acier (15) une face recouverte d'une couche de zinc (16) et une autre face recou-

verte d'un revêtement composé d'une sous-couche de zinc (16) recouverte d'une couche (17) minérale continue.

8. Produit selon la revendication 7 caractérisé en ce que la couche supérieure (17) du revêtement composite est une couche d'aluminium.

9. Produit selon la revendication 7 caractérisé en ce que la couche supérieure (17) du revêtement composite est un alliage delta fer-zinc.

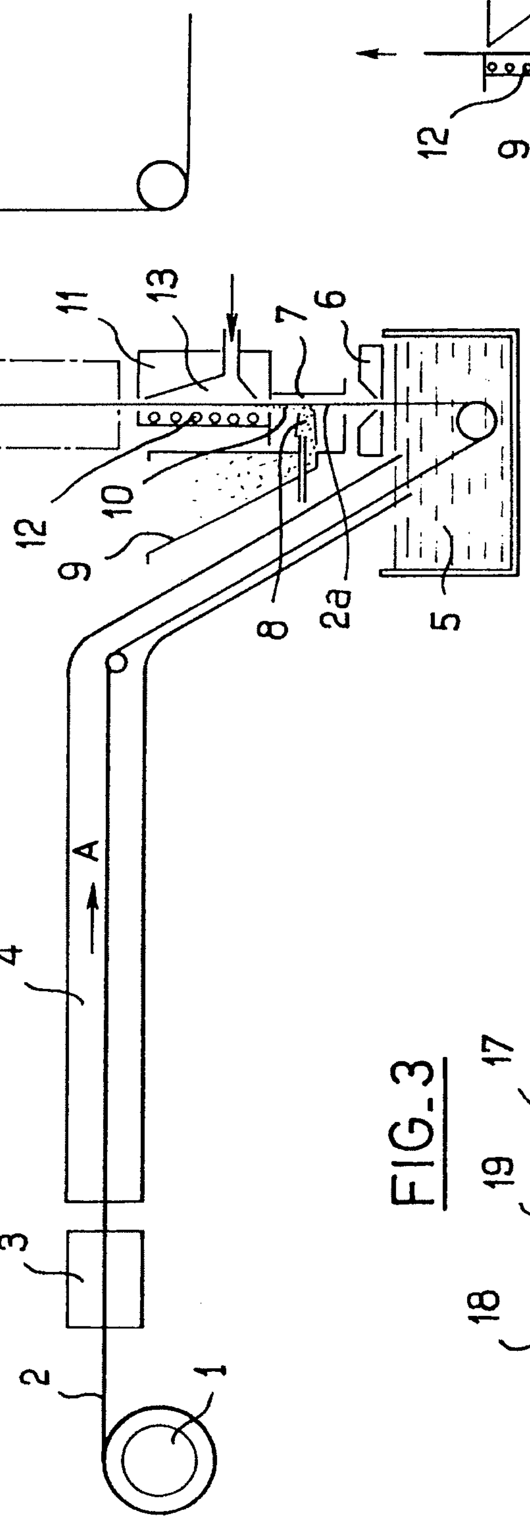


FIG.1

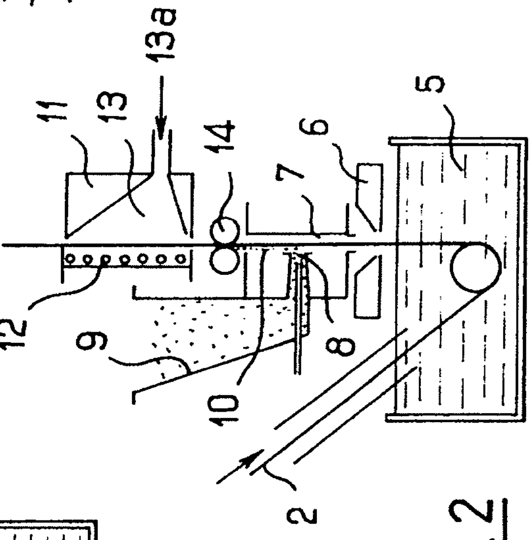


FIG.2

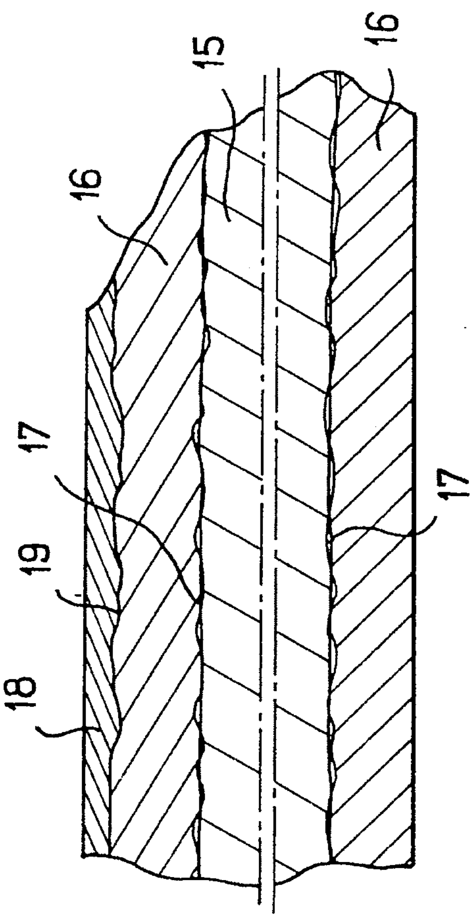


FIG.3

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RAPPORT DE RECHERCHE

établi sur la base des dernières revendications déposées avant le commencement de la recherche

N° d'enregistrement national

FR 8915785
FA 437302

DOCUMENTS CONSIDERES COMME PERTINENTS

Catégorie	Citation du document avec indication, en cas de besoin, des parties pertinentes	Revendications concernées de la demande examinée
A	PATENT ABSTRACTS OF JAPAN, vol. 9, no. 306 (C-317)[2029], 3 décembre 1985; & JP-A-60 145 368 (NIPPON KOKAN K.K.) 31-07-1985 * Abrégé *	1,2
A	FR-A-2 410 681 (INLAND STEEL CO.) * Figure 1 *	1
A	FR-A-2 351 187 (INLAND STEEL CO.) * Figure 1; page 3, lignes 30-36 *	1
A	PATENT ABSTRACTS OF JAPAN, vol. 7, no. 69 (C-158)[1214], 23 mars 1983; & JP-A-58 003 956 (NIPPON KOKAN K.K.) 10-01-1983 * Abrégé *	1,3
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DOMAINES TECHNIQUES RECHERCHES (Int. Cl.5)

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PATENT APPLICATION **A1**

Filing date : 30.11.89 Priority : Date of laying-open to the public of the application : 31.05.91 Bulletin 91/22 List of documents cited in the search report : refer to the list at the end of the present document References to other national documents :	Applicant : FABRIQUE DE FER DE MAUBEUGE (plc) – FR Inventor : Bretez Michel Title holder : Representative : Cabinet Boettcher

METHOD FOR COATING A METAL PLATE OR SHEET, AT LEAST ONE FACE OF WHICH HAS A DUAL MINERAL COATING – STRIP PLATE STEMMING FROM THE METHOD.

With this method, at least one face of the strip (2) exiting from the galvanization bath is sown with a metal or organic powder, the zinc still being liquid, and surface heating of this face (2a) is performed by means of infrared emitters (12) simultaneously with powerful cooling of the other face by a cooled fluid (13).

One of the most widespread techniques for ensuring protection of a steel metal sheet is continuous hot dip galvanization. The protective layer thus produced is most often a zinc-based alloy. The essential flaw of the zinc is a medium resistance to corrosion. To overcome this, various techniques have been devised notably dealing with the addition of a certain amount of aluminium in the coating bath (typically 5%) or even creating an aluminium-zinc alloy (typically containing 55% of aluminium). However, these alloys as compared with standard alloys with more than 95% zinc have the drawback of only providing low galvanic protection of the edges. Next, their application is more expensive, requiring higher bath temperatures. Other techniques consist of producing coil coating in line behind galvanization, the paint layer deposited on the zinc layer increasing the strength of the coating. The products which result from this technique are not universally used, considering the relative brittleness of the organic coating which poorly resists to subsequent forming operations.

In order to make the product more easily weldable, it is also known how to proceed after dipping galvanization with heat treatment of galvanized product in order to promote formation of an iron-zinc intermetallic alloy which has the required properties for good weldability. On the other hand, this alloy is brittle and the sheet poorly lends itself to operations with significant deformation, during which a loss of adherence of the coating is observed.

The present invention intends to propose another type of coating, always including zinc, which is a material which is easy to

apply and relatively inexpensive, which may optimally meet the various constraints to which a "galvanized" sheet is subject both from the point of view of corrosion and of the field of use.

For this purpose, a first object of the invention is a method for producing a coated metal material consisting of producing the coating of a plate-shaped or strip-shaped basic substrate by dipping this substrate in a bath of zinc or zinc alloy and of projecting on the still molten zinc skin, borne by at least one face of the substrate, another mineral compound in the form of a powder, which comprises at least the additional step of heating up the sown face by means of a radiating heat source and powerfully cooling the opposite face of the substrate.

The result of this method is melting of the powdery element which forms a continuous layer at the surface of the zinc, the nature of which depends on the mineral element and which preserves a zinc (or alloy) sublayer ensuring galvanic protection of the edges of a thereby coated metal sheet part.

This is notably the case when the powder is aluminium powder. In this case, in addition to the galvanic protection of the edges, the resistance to corrosion of the product is very significant since the aluminium "film" surmounting the zinc is oxidized at the surface, a sealed alumina layer thereby protecting all the sublayers.

When the powder is iron, a slight diffusion of iron into the upper zinc layer occurs so as to form a delta iron-zincintermetallic alloy which is very weldable. Although this alloy is hard, the zinc sublayer forms a sort of binder which preserves the adhesion of the coating to the base substrate.

The mineral powder may be formed by another product such as a ceramic or metal oxide which "vitrifies" under the effect of heat radiation.

The method according to the invention may include an intermediate step consisting of compacting the powder projected on

the zinc film before the heat treatment. This compacting may be achieved by lamination under low pressure.

The method of the invention is applied as a subsequent step to continuous or batchwise hot dip galvanization. In the case of continuous galvanization, as the substrate is a continuous strip, the method consists of having the strip successively run in a bath of molten zinc or zinc alloy, in an enclosure for projecting the mineral powder and then in a thermal enclosure including radiant heating members on one side of the strip, and a device for cooling the strip by conduction on the other side.

If necessary, before the entry of the strip into the thermal enclosure, the strip passes into a station for compacting and spreading out the powder, this station including a low pressure rolling mill for this purpose.

The second object of the invention lies in a product which includes, on a substrate with the shape of a steel strip or plate, a face covered with a zinc layer and another face covered with a coating consisting of a zinc sublayer covered with a continuous mineral layer, wherein this mineral layer may be formed by a metal layer typically of aluminium, an iron-zinc alloy or a ceramic either glassy or not.

The exemplary embodiment of the invention given hereafter relates to a method for making a metal sheet galvanized on its two faces and covered with a thin aluminium layer on one of them.

Reference will be made to the appended drawings wherein:

- Fig. 1 schematically illustrates a line for continuous production of such a product,

- Fig. 2 illustrates an alternative embodiment of Fig. 1 having a station for compacting the sown metal strip,

- Fig. 3 is a section of a coated metal strip according to the invention.

A spool of strip steel 1 delivers a strip 2 which, after passing in thermal and/or chemical preparation units 3 and 4 runs into a bath 5 of molten zinc or zinc alloy, in the direction A. With a wiping device 6, it is possible to adjust the thickness of the zinc layer, carried along by the strip, which remains liquid. The strip enters an enclosure 7, if need be maintained at a temperature, in which it receives on one of its faces 2a a projection (pneumatic or other) of aluminium powder, by means of a projecting system 8 fed by a hopper 9. The aluminium powder 10 is retained and carried away by the strip, or at the very least a certain fraction of the projected powder which itself will have been adjusted depending on the strip's running speed and on many other parameters so as to obtain the final thickness of aluminium with which the product is intended to be covered.

The strip then penetrates into a thermal enclosure 11 which has on the side of the face 2a sown with aluminium powder, a set 12 of radiant heating members and on the other side, a powerful cooling device 13, for example a nozzle for blowing a gas 13a cooled by expansion or vaporization from its liquid state (notably CO_2).

The members 12 may be of any known type. They thus comprise infrared sources and laser radiation sources.

In this thermal enclosure, the set of radiant members is arranged so that the strip is subject to a significant thermal "shock". It is seen that the radiation only has a very superficial effect on the face 2a and that the heat is concentrated at the surface of the zinc on which the aluminium grains transformed into a liquid film form an additional barrier reflecting infrared radiation. This type of heating, which benefits most from the thermal inertia of the metal sublayer, with the powerful cooling of the other face, practically prevents any diffusion of the aluminium into the zinc layer.

Fig. 2 differs from Fig. 1 by the placement of a section 14 for compacting the powder in the zinc matrix and for improving its distribution. This section is interposed between the projection

enclosure 7 and the heat treatment enclosure 11. It may simply be formed by a rolling mill acting with low pressure on the strip 2.

The product obtained after cooling, if need be with a cooling section R, seen in an enlarged sectional view, appears as illustrated in Fig. 3.

The steel core 15 of the product is covered on both of its faces with a zinc layer 16, with an interface area 17 in which iron-zinc intermetallic alloys are found. On the face sown with aluminium powder, corresponding to the face 2a of Fig. 1, an aluminium film 18 is found, the thickness of which depends on the amount of powder "trapped" by liquid zinc in the projection enclosure 7, which has a very clear lower frontier 19 with the zinc in the sublayer. It is seen that there is practically no diffusion of aluminium into the zinc, which is very appreciable in the case of such a coating. Indeed, if there was significant diffusion, the latter would have certainly generated formation of Fe_2Al_5 which is a very hard compound which may be detrimental to the proper strength of the coating towards deformations which it is intended to undergo during forming of the metal sheets, and in any case, forming a source of heterogeneity of the latter coating.

The described example is not limiting and the invention relates to any product covered in this way with a mineral compound projected on a zinc layer still in a molten state and heated very rapidly by infrared or laser radiation in order to obtain the melting and its spreading out as a surface layer on the zinc. Thus, the powder may be iron and in this case, diffusion of the iron into the zinc occurs over a small thickness in order to produce a delta type intermetallic alloy which improves the weldability of the product.

Given the significant concentration of the calories radiated at the "skin" of the zinc, high temperatures may be reached which allow "vitrification" of mineral oxides and ceramics.

CLAIMS

1. A method for producing a coated metal material, consisting of achieving the coating of a plate-shaped base substrate (2, 15) by dipping this substrate in a bath (5) of zinc or zinc alloy, and of projecting on the still molten zinc film, borne by at least one face (2a) of the substrate, another mineral compound as a powder, characterized in that it comprises at least the additional step of heating the sown face (2a) by means of a radiant heat source (12) and of simultaneously and powerfully cooling (13) the opposite face of the substrate.

2. The method according to claim 1, characterized in that it includes the step prior to heating up, of compacting the powder in the zinc matrix.

3. The method according to claim 1 or claim 2, characterized in that the mineral powder is aluminium powder.

4. The method according to claim 1 or claim 2, characterized in that the mineral powder is iron powder.

5. The method according to any of the preceding claims, characterized in that, the substrate being a continuous strip (2), it consists of having the strip (2) successively run in a bath (5) of molten zinc or zinc alloy, in an enclosure (7) for projecting the mineral powder and then in a thermal enclosure (11) including on one side of the strip, radiant heating members (12) and on the other side, a device (13) for cooling the strip by conduction.

6. The method according to claim 5 taken as dependent on claim 2, characterized in that it consists of having the strip pass into a rolling mill (14) after the projection enclosure (7) and before the thermal enclosure (11).

7. A coated plate or strip product characterized in that it includes on a steel substrate (15) a face covered with a zinc layer